has appeared on the effects, if any, which modifications of the surroundings exert on this attraction is very remarkable. Newton's hollow pendulum experiments, repeated with greater accuracy by Bessel, seem to be almost the only investigations which have been published on what may be called the physical properties of gravitational attraction. As far as we know, the attraction between two given masses depends merely upon their geometrical configuration; it is independent of the medium between them, of the physical state of the masses, whether they are solid, liquid or gaseous, amorphous or crystalline; it does not depend upon the temperature of the masses. Indirect evidence, often derived from the Cavendish experiments, shows that the preceding statements must at least be very approximately true. Again, chemical analysis is founded on the hypothesis that the weight of an atom of a chemical element is unaltered whatever chemical combinations it may form, or whatever the temperature to which it may be raised. It is, however, often difficult to tell the degree of approximation to the truth of the preceding statements which is indicated by such indirect evidence, and a direct experimental investigation to determine an inferior limit to the accuracy of some of the preceding statements would not be superfluous. Take the case, for example, of the statement that the weight of an atom cannot be altered by chemical combination: it would be for the advantage of science if this were proved with the utmost possible accuracy attainable by present methods for some definite chemical combinations. The question is of interest in connection with the view that the atoms of elements are aggregations of atoms of some primordial substance not very much lighter than hydrogen. The values of the atomic weights of the elements is inconsistent with this view if each atom of the primordial element retains its weight unaltered in the complex atom. If, however, it suffers a slight change of weight, then we might expect to find traces, though perhaps faint ones, of such a change in ordinary chemical combinations.

Another question which has excited some interest is a possible connection between the magnitude of gravitational attraction and temperature. Prof. Hicks has pointed out that Baily's results gave a value for the mean density of the earth which uniformly diminished as the temperature increased, indicating, if the effect is a real one, that the attraction between two masses increases with the temperature, and von Sterneck, in his experiments at Freiberg, found a remarkable relation between the temperature and the value of gravity. Prof. Poynting discusses these and other results, and comes to the conclusion that they are to be explained by other causes, and do not afford any evidence at all that the attraction between bodies varies with the temperature. The point is one which has a direct bearing on Prof. Poynting's own experiments, as the final value for the mean density is got by taking the mean of two sets of experiments, and as the temperature in the two sets differed by about 3·5° C., an uncorrected temperature effect would affect the result.

We are very glad to find from this essay that Prof. Poynting is engaged on an investigation as to whether the attraction between two crystals depends on the relative position of their axes.

The second part of the essay consists of Prof. Poynting's paper "On a Determination of the Mean Density of the Earth," published in the *Phil. Trans.* for 1891. This, in addition to the actual determination of the mean density, is almost a treatise on the method of using a balance so as to get great sensitiveness. The work is a model of patient care and skill, as well as of clearness of exposition, and we feel as we read it that the utmost has been made out of the apparatus and the method. Prof. Poynting is of opinion that it is only air-currents which prevent the balance being used with an accuracy far beyond anything hitherto approached; the ordinary balance is more sensitive than the torsion balance to air-currents, since these produce the greatest disturbance in the vertical direction, which is the direction of displacement in the ordinary balance. Prof. Boys has shown that to minimise the effect of air-currents the size of the apparatus ought to be reduced as much as possible. Prof. Poynting says that if he were designing his apparatus again, instead of using, as he did, an exceptionally large balance, he would go to the opposite extreme and use a very small one.

Of all the methods hitherto used to determine the mean density of the earth, the arrangement used by Prof. Boys seems to be the one capable of the greatest accuracy. There are, however, certain points about the method of the common balance, such as the simplicity of the most important measurements, and the absence of the necessity to determine a time of swing with great accuracy, which make it worthy of such a work as Prof. Poynting has devoted to it.

The mean density of the earth found by Prof. Poynting is 5·49. Prof. Boys' result is 5·53.

MINING.

A Text-book of Ore and Stone Mining. By C. Le Neve Foster, B.A., D.Sc., F.R.S. 8vo. Pp. 744, with Frontispiece and 716 Illustrations. (London: C. Griffin and Co., Limited, 1894.)

IN view of the paramount importance of the production of minerals to Great Britain, and of the constant enterprises for working gold ores and other minerals in most of our colonies, it is certainly remarkable that there has hitherto been no satisfactory systematic treatise on metalliferous mining available. It is a matter of congratulation, therefore, that so eminent an authority as Dr. Le Neve Foster has found time, with his many duties as H.M. Inspector of Metalliferous Mines, and as Professor of Mining at the Royal College of Science and Royal School of Mines, to fill up so important a gap in technical literature. His compendious volume will undoubtedly be warmly welcomed as an invaluable work of reference, not only by mining students, but by all English-speaking mining engineers. The subject is so extensive, that the author's task of keeping his text-book within moderate limits, without erring on the side of omission, was one of considerable difficulty. He has, however, been thoroughly successful; and the extremely methodical arrangement of the material obviates, as i did in the case of Rankine's engineering treatises, the possibility of the work becoming rapidly obsolete.

The subject has been divided into the following chapters: (1) Occurrence or manner in which the useful minerals are found in the earth's crust; (2) prospecting or search for minerals; (3) boring; (4) excavation; (5) supporting excavations; (6) exploitation or working away of minerals; (7) haulage or transport along roads; (8) winding or hoisting in shafts; (9) drainage; (10) ventilation; (11) lighting; (12) descent and ascent; (13) dressing; (14) principles of employment; (15) legislation; (16) condition of workmen; and (17) accidents. The mining of coal is not dealt with; a special treatise having been published, as a companion volume, by Mr. H. W. Hughes.

In the first chapter, the time-honoured definition of mineral veins as the contents of fissures is wisely expanded by the author. Veins, he states, are tabular mineral deposits formed since the enclosing rocks, and either occupying cavities formed originally by fissures, or consisting of rock altered in the vicinity of fissures. There can be no doubt that many so-called fissure-veins are really substitutional deposits, and the necessity for some change in the definition is apparent. The author enters a timely protest against the use of the word "gangue" for the veinstone, lode-stuff, or matrix. Mistranslated from the German *Gang* (vein) into French, and thence into English, it has lost its original meaning, and should be consigned to oblivion.

The fascinating but perplexing subject of the formation of mineral veins is clearly and concisely dealt with. Sandberger's lateral secretion theory, assuming that the minerals were leached out of the adjacent rocks and re-deposited in the vein cavity, is regarded by the author as not entirely proven. This view, it is interesting to note, is shared by Posepny, who in a paper read, last year, at the Chicago Congress, published since the appearance of Dr. Le Neve Foster's treatise, expresses the opinion that Sandberger's theory suffers from several fundamental defects, and by being accepted as a simple and welcome explanation of the genesis of ore-deposits, has hindered the progress of knowledge.

In studying the mode of occurrence of minerals, abstract definitions are not sufficient. The student must see how they can be applied in practice. The author, therefore, gives a carefully chosen series of examples of the modes of occurrence of the more important minerals arranged in alphabetical order. The thoroughness with which he deals with this section is evident from the fact that he gives accounts of the occurrence of carbonic acid, of petroleum, and of ice. Liquefied carbonic acid is now a regular article of commerce in Germany, whilst the American ice trade affords employment to 12,000 men, 1000 horses, and 100 steam engines. Full descriptions of the mining of ice, to which the author might usefully have given references, have been published in Helland's Norwegian treatise on mining, and in a paper read in 1883, by Mr. W. P. Blake, before the American Institute of Mining Engineers.

The eleven chapters dealing with mining proper cover some 450 pages, and include descriptions and illustrations of all the important appliances used in mining work, including the most recent inventions. Indeed, if fault can be found with this section, it is that the author devotes too much space to inventions so recent that their advantages have not been thoroughly tested. The description of the Franke drill, for example, the smallest and lightest boring machine in practical use, introduced last year at the Mansfeld copper mines, occupies more space than that of the modern stamp battery.

The chapter on dressing, under which term the author includes the processes by which the miner prepares his product for sale, or by which he extracts a marketable product from it, covers 100 pages, and is of special interest. Bearing in mind the needs of teachers, the author supplies useful information enabling the student to construct ingenious models of glass-tubing, &c., to illustrate the principles of motion in water and in air, and the construction of dressing appliances. A mixture of like-sized grains of coal, calcspar and galena, minerals of distinctly different colour and specific gravity, is used in these experiments.

The author's classification of the dressing processes employed is quite novel. There are three main divisions, according as the process is effected solely by mechanical means, or is based upon the physical or chemical properties of the minerals treated. The main divisions are subdivided in the following manner:—

I. *Mechanical processes.*—(1) Washing in order to separate clay, mud, and sand; (2) hand-picking; (3) breaking-up, subdivision, or shaping; (4) agglomeration or consolidation; (5) screening or sifting—that is, classification according to size.

II. *Processes depending upon physical properties.*—(1) Motion in water; (2) motion in air; (3) desiccation; (4) liquefaction and distillation; (5) magnetic attraction; (6) separation according to degree of friability.

III. *Processes depending upon chemical properties.*—(1) Solution, evaporation, and crystallisation; (2) atmospheric weathering; (3) calcination; (4) cementation or precipitation by iron; (5) amalgamation.

This classification cannot fail to be of the utmost value to the student, even if the subdivisions are not strictly defined in reality. A carefully considered classification of this character converts dressing into a rational science, instead of leaving it, as is the case in the existing treatises on the subject, an unsystematic collection of heterogeneous facts. One cannot but regret that the exigencies of space have compelled the author to give but meagre information regarding some of the most important mechanical appliances. Dressing is, however, a special subject of sufficient importance to command a literature of its own, and it is to be hoped that the author may some day be induced to expand his classification into a complete treatise.

The 711 illustrations given by the author are clear and effective; and in all important cases the scale is indicated. The frontispiece, representing an overhand stope at the 274-fathom level at Carn Brea Mine, Cornwall, from a photograph by Mr. J. C. Burrow, is a most artistic piece of work and a triumph in underground photography. With his characteristic minute accuracy in detail and in nomenclature, the author has introduced the expression "274-fathoms level" in place of the usual "274-fathom level." No doubt he can bring forward arguments in favour of this practice, which he adopts throughout the book; but to Cornish ears it will sound as oddly as if he alluded to a 2-feet rule, or to a 2-years old colt, or as if he spoke of a Guardsman as a "six-feeter."

A very full and accurate index greatly adds to the value of the work. The insertion of the names of von Cotta, von Groddeck, and von Sandberger under the letter V is, however, open to objection.

Prof. Le Neve Foster is to be congratulated on having enriched our technical literature with a contribution of substantial value. Undoubtedly the best book on the subject in the English language, it bears comparison with the treatises of Callon and Haton de la Goupillière in French, and with those of Serlo and Koehler in German. It should find a place in every mine office, and, by being carefully studied by mine managers, should help to raise the British ore and stone mining industries from their present depressed condition.

BENNETT H. BROUGH.

DR. ADLER'S OBSERVATIONS ON GALL FLIES.

Alternating Generations: a Biological Study of Oak Galls and Gall Flies. By Hermann Adler, M.D., Schleswig. Translated and edited by Charles R. Straton, F.R.C.S., Ed., F.E.S. With illustrations. (Oxford: Clarendon Press, 1894.)

THE order *Hymenoptera* has never been a popular study, in the sense in which the *Coleoptera* and *Lepidoptera* have become so during the last century, but it probably numbers among its votaries nearly three times as many students as any of the remaining orders. Nor is this surprising, for although it cannot compete with the *Lepidoptera* in beauty of colouring, it surpasses the *Coleoptera* in its variety of form, and is probably more numerous in species than any other order. It supplies us with some of the most valuable products which are yielded by insects, such as honey and ink, and stands at the head of the insect world, both in intelligence and in diversity of habits.

The *Aculeata*, or ants, bees, and wasps, and, after these, the *Tenthredinidæ*, or saw-flies, have generally received most attention from those entomologists who have specially devoted themselves to the study of the *Hymenopteræ*. But within the last twenty or thirty years, several entomologists have occupied themselves with the study of the *Cynipidæ*, or Gall Flies, and have discovered a system of alternate generations in these insects almost as remarkable as that which had previously been observed in the *Aphididæ*, or Plant-lice, which belong to the very different sub-order *Homoptera*.

One of the most important contributions to this subject was Dr. Adler's treatise, "Über den Generationswechsel des Eichen-Gallwespen," which was published in the *Zeitschrift für wissenschaftliche Zoologie* for 1881 (vol. xxxv.), with three coloured plates; and it is this work which Dr. Straton has now brought within the reach of every English entomologist.

As a rule, works on many branches of science become obsolete shortly after publication, and are seldom required except by specialists; but this does not apply to observations on transformations and habits. Men who have sufficient patience, taste and opportunity to make such observations of real value are few and far between, and their results, if sufficiently accurate, remain of permanent value, however much they may be enlarged by future observations. Hence Dr. Straton has rendered a real service to science by publishing an English edition of a work of this description, which was originally issued several years ago in a costly periodical, which would hardly be accessible, even to those who can read the original, except in metropolitan or university libraries. Dr. Adler's work has been carefully and accurately translated, including his descriptions of the insects observed, his table of alternating generations, and his observations on gall-formation, oviposition, &c.; and the coloured plates have been faithfully reproduced, though the original stones had been destroyed.

Dr. Straton has added an introduction, a chapter on *Cynips Kollari*, synoptical tables of galls, a classification of the *Cynipidæ*, and a bibliography and index. The introduction deals with the history of the study of galls, and the questions of parthenogenesis, alternating generations, &c., in arthropods, and more especially in the *Cynipidæ*, the changes in the ovum and sperm-cells being described in detail, with reference to the views of Weismann and others; and Dr. Straton's own remarks will be found interesting to embryologists in general. Incidental remarks on gall parasites, and other points unconnected with the main subject of the book, are occasionally introduced.

We have only to regret that it has not occurred to Dr. Straton to add the principal bibliographical references to descriptions, &c., of each species, and a note as to whether it is common or rare in England. These additions, which might have been placed between brackets, to distinguish them from Dr. Adler's work, would have added to the usefulness of the book, which may probably penetrate to country places where the information which it contains cannot be supplemented by reference to larger works; to which, however, it is very necessary to refer the student, that he may know what to consult if he wishes to pursue the subject further. This want is only imperfectly supplied by a bibliography, absolutely necessary as this is for advanced students, and also to indicate the extent of an author's reading, and the sources from whence he has derived his information.

W. F. K.

OUR BOOK SHELF.

Hygiene. By J. Lane Notter, M.A., M.D., and R. H Firth, F.R.C.S. Pp. 374. (London: Longmans, Green, and Co., 1894.)

Primer of Hygiene. By Ernest S. Reynolds, M.D. Pp. 158. (London: Macmillan and Co., 1894.)

THOUGH it is not expressly stated that Dr. Notter's book "has been designed to meet the requirements of the syllabus of the Science and Art Department," the work is issued in the series of manuals published by Messrs. Longmans for students working up for South Kensington examinations, from which fact it may be inferred that such students will use it as a text-book. And as the author is an examiner in hygiene under the Department of Science and Art, his book doubtless contains the kind of knowledge that commands marks. Therefore teachers would do well to adopt it for their classes; and all writers of other text-books covering the same ground may regard